REMARKS

The Office Action mailed on November 26, 2003 has been received and reviewed. Claims 1-24 are in the case. Claims 1-24 were rejected under 35 U.S.C. 103(a) as being unpatentable over Kaufman et al. (5,442,733) in view of Lathrop (6,597,359), Jennings (6,430,589), Sowizral (6,445,391) and Greene (5,579,455).

In light of the rejections, a review of the present invention may help clarify the novelty of the Applicant's claims over the cited prior art. As shown in Figures 12-16 and elsewhere, the present invention in disclosed embodiments recursively casts and subdivides a ray bundle towards one or more graphical objects in order to render a graphical scene. Large ray bundles are advanced a relatively large distance until a proximity test for the bundle (center or other reference point) indicates that the ray bundle is within a selected proximity to an object to be rendered. The ray bundle is then subdivided into smaller ray bundles which are advanced a smaller distance (see Figure 14).

The proximity test indicates whether individual rays within the ray bundle may potentially impinge upon the object or whether the entire bundle of rays is free from intersections with the object. Using a proximity test facilitates detecting potential occlusions on the surface of a graphical object for any ray within the entire ray bundle. To ensure valid indication of potential occlusions the tested proximity is selected to correspond to the ray bundle size and casting distance. See page 10 lines 14-24, page 11 line 21 to page 12 line 27, and the description of Figures 12-16 on pages 33-39, particularly Figures 12 and 14.

The ray bundle casting and recursion provided by the present invention increases the performance of ray casting and ray tracing over previous solutions. Large bundles of rays may be cast large distances with a single proximity test rather than conducting an occlusion or proximity test for each ray in the bundle.

The present invention is highly complimentary to existing techniques for recursively accessing graphical objects such as recursive bounding volumes and space subdivision (i.e. spatial partitioning of graphical objects) ubiquitously found in the prior art.

Applicant asserts that the cited prior art is not directed to ray bundle casting and recursive subdividing of ray bundles as disclosed and claimed by the Applicant. Specifically, Kaufman discloses a method that guarantees finding adjacent voxels in a casting path for a particular ray using a concept known as voxel connectivity. Voxel connectivity is used to compute whether the adjacent voxels along the casting path share a face, edge, or corner and thereby compute an upper bound for the casting distance that gaurantees intersecting the next voxel in the casting path (see column 5 line 45 to column 6 line 45 of Kaufman.)

To clarify a possible point of confusion, Applicant notes that the X, Y, and Z offsets shown in Figure 8 of Kaufman are memory offsets for adjacent voxels within the cubic frame buffer for each dimension in cubic space (see column 10 line 32 to column 11 line 12) and not the X, Y, and Z casting distances depicted in Figure 11 of Applicant's specification. Therefore, Kaufmann is limited to testing adjacent voxels and does not disclose ray bundles and large casting distances such as depicted in Figure 14 of Applicant's specification.

Applicant also notes that the secondary rays produced by Kaufman are not the result of subdividing ray bundles or of any type of ray bundle recursion. Rather the secondary rays of Kaufman are generated in response to reflection and/or transmission of a primary ray in response encountering a non-transparent voxel (column 2 lines 49-52, column 12 lines 36-39, and column 15 lines 18-36).

In contrast to Kaufman, Lathrop discloses a space subdivision technique that uses a directed graph such as a tree to store objects in a recursively accessible manner. Portions of the directed graph that are blocked or outside the viewing frame need not be accessed during the rendering process (see column 3 lines 8-43).

Applicant reiterates his assertion that ray bundle casting and recursive subdivision of ray bundles is not disclosed within the cited prior art and that the claims as originally submitted are in condition for allowance. Specifically, the prior art does not disclose casting an entire ray bundle as a unit, proximity testing of an entire bundle and recursively subdividing ray bundles as claimed by the Applicant.

In order to emphasize the novelty of the present invention over the prior art, Applicant has amended the limitation of a 'proximity test' cited in several claims to read a 'bundle proximity test'. Applicant asserts that this amendment simply clarifies the claimed invention and is not an amendment crafted to avoid the prior art. Specifically, Applicant asserts that in light of Applicant's specification and each claim as a whole, 'a proximity test' as cited in each original claim is synonymous with 'a bundle proximity test' as cited in the current claims.

Applicant thanks Examiner Nguyen for the telephone interview of 18 February 2004 in which the Examiner discussed a draft of this amendment and agreed with the Applicant that bundle casting and recursive subdivision of ray bundles are not disclosed in the cited prior art and that an additional search is warranted.

For the reasons stated above, particularly in light of the clarifying amendments, Applicant asserts that claims 1-24 are in condition for allowance and respectfully requests prompt allowance of the pending claims. In the event that the Examiner finds any remaining impediments to the prompt allowance of any of these claims which could be clarified in a telephone conference, the Examiner is respectfully urged to initiate the same with the undersigned.

DATED this 26 day of February, 2004.

Respectfully submitted,

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